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THE MOTHER MAPS

OF THE

UNITED STATES

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THE MOTHER MAPS OF THE UNITED STATES

BY HENRY GANNETT.

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INTRODUCTION.

We read of topographic maps and of geographic maps. Both of these classes of maps represent similar features—the drainage and other basins of water, the relief of the earth's surface, and the artificial features, such as railroads, roads, towns, houses, etc. The distinctions between them are merely those of scale and of area represented. A map on a small scale and covering a large area is commonly known as a geographic map.

Mother maps are those made from original sources of information. Commonly they are the maps for the production of which a survey was carried on, while compiled maps are secondary productions, being reduced or changed in certain respects from the mother maps. Topographic maps may be mother maps or compiled maps. Geographic maps are in most cases compiled maps.

Most of the countries of Europe have been surveyed under a uniform plan or system and mother maps produced therefrom. In these cases the mother map is everywhere of uniform quality and character. In the United States, on the other hand, many partial surveys have been made under independent authorities

and of widely differing degrees of accuracy, and the maps resulting therefrom differ in scale and value.

It is my purpose to sketch the principal of these surveys, characterizing the methods employed and the accuracy and value of the maps which have resulted from them, in order to learn what parts of the country have been well mapped, what parts have been indifferently mapped, and what parts have not been mapped at all. Such surveys have been executed under authority of the general government and of state governments and have been carried on by private enterprise.

SURVEYS OF THE UNITED STATES GOVERNMENT.

The Coast and Geodetic Survey.—The most prominent organization under the general government, and that one which is executing the most accurate work, is the United States Coast and Geodetic survey, which, commencing its actual work in 1832, has continued down to the present time. During this period nearly the entire coast line of the Atlantic, Gulf and Pacific, with the exception of the coast of Alaska, has been mapped, together with a strip of inshore topography ranging from half a mile to five miles in breadth. The area of topographic surveys is not extensive, being at the present date only about 34,000 square miles. In addition to this work, triangulation has been extended inland in various directions for a number of different purposes: It has been extended southwestward along the Appalachian mountains for the purpose of furnishing a suitable control for the work along the southern coast; it has been extended westward from the Atlantic coast in the neighborhood of the 45th parallel of latitude to central Kansas, and from the Pacific coast eastward to eastern Utah for the purpose of ultimately joining together by triangulation the work upon the eastern and western coasts. For assisting in state surveys, triangulation has been done in the interior in many of the states, among which are New Hampshire, Massachusetts, New Jersey, Wisconsin, Indiana, Kentucky and Tennessee. Besides all this triangulation, numerous astronomic determinations have been made in the interior.

The triangulation of this organization is of the highest order of excellence. Topographic details are mapped by the plane-table. The plane-table sheets are in the main made on a scale of 1:10,000, or about 6 inches to 1 mile, and are published on

various scales from 1:10,000 to 1:80,000. Contour lines at vertical intervals of 10 or 30 feet are located on the planetable sheets. The small scale charts are published in hachures, those on the larger scales commonly in contours.

Geological Survey.—The United States Geological survey is the only organization which has ever undertaken to map the United States under a comprehensive and well defined plan, and it has surveyed a greater area than any other organization. It was formed in 1879 upon the discontinuance of the three rival western surveys, namely, the Hayden, Wheeler and Powell surveys. At first it was restricted in its operations to the public domain, but was soon authorized by law to include the entire United States. The work of topographic surveying on a large scale, with a view to mapping the entire country, was commenced in 1882 and has been prosecuted actively since that time.

The work, wherever practicable, is controlled by triangulation, which, though not of geodetic refinement, is suitable for the control of the maps upon the adopted scales. Where it is not practicable to carry on triangulation for control, traverses are run for that purpose with instruments of considerable power and with all possible precaution to prevent the accumulation of sensible error.

Aside from the primary control, location is effected by graphic methods. The planetable is used for secondary triangulation and for traversing. Heights are measured with the spirit level, by vertical angles, and by aneroid. The maps are now published on two scales, one of 1:62,500, or about one mile to an inch, the other of 1:125,000, or about two miles to an inch. Considerable work has been executed on the scale of 1:250,000, but that scale has been abandoned. Relief is expressed by contours, the intervals ranging from 5 feet up to 200, depending upon the scale and upon the degree of relief of the country.

The Geological survey has worked in co-operation with four states, namely, Massachusetts, Rhode Island, Connecticut and New Jersey, and has completed the surveys of those states. It has also surveyed large areas in New York, Pennsylvania, Maryland, Virginia and West Virginia, the southern Appalachian region, Louisiana, Texas, Arkansas, Illinois, Iowa, Wisconsin, Missouri, Kansas, and the western states and territories generally. Altogether an area of 350,000 square miles has been surveyed. The maps are engraved on copper. Three plates

are required, the culture, drainage and relief being printed in different colors.

Lake Survey.—The shores of the Great lakes and of the St Lawrence river have been mapped, together with a narrow strip of topography, by the organization known as the United States Lake survey, which was under the control of the Engineer corps of the United States army. Besides mapping the shores of the lakes, this organization carried a belt of triangulation from the head of lake Michigan to that of lake Erie across the southern end of the peninsula of Michigan, and another strip of triangulation through eastern Illinois to the neighborhood of Vincennes, Indiana, and located by astronomic means a large number of points in the lower peninsula of Michigan. All these determinations of positions were connected directly with section corners of the United States Land survey, to be hereafter described.

The work of this organization was of a high order of excellence, comparable in most respects to that of the United States Coast and Geodetic survey.

Engineer Surveys.—In connection with river improvements, the United States Engineer corps has made surveys of many navigable rivers. In many cases these are merely local surveys covering trifling areas, but in the cases of the lower Mississippi and the Missouri river excellent maps, controlled by triangulation, have been produced.

Army Expeditions.—The western part of the United States has, ever since its acquisition, been a favorite field for exploration and survey. For a long time the War department monopolized this field. The explorations began with the famous expedition of Lewis and Clarke in the early years of the century, followed by those of Long, Pike and Fremont. Then, in the early fifties, came that remarkable series of explorations known as the Pacific railroad surveys. These were followed by numerous other army expeditions, some of which are of comparatively recent date. Altogether a large number of military parties have traversed the Cordilleran region and each of these expeditions has furnished more or less geographic information.

Their methods of survey were, in nearly all cases, similar: A traverse survey of the route was made, using the compass for directions. Distances were measured by the revolutions of a wheel or by estimates based upon the time of travel. Points off the line were intersected upon and thus located roughly with refer-

once to the line of travel, and, resting upon this rather imperfect skeleton, the topography in sight of the line was sketched, while that out of sight of the line was often added from the statements of hunters, trappers and Indians. These lines were checked at intervals by astronomic determinations, the latitude being determined by altitudes of the sun or a star, the longitude by moon culminations or lunar distances, or by chronometer.

Many such lines were run in various directions over the Cordilleran region. From such as were at that time available General G. K. Warren constructed in 1857 the first map of the western United States which was in any way worthy of the name of map.

Nearly all of the areas thus explored have since been resurveyed by more accurate and detailed methods.

Survey of the 40th Parallel.—In 1867 Mr Clarence King, a civilian in the employ of the War department, organized a survey for the exploration of a strip of country adjacent to the line of the Union Pacific and Central Pacific railroads, from the longitude of Cheyenne on the east to the eastern boundary of California on the west, and about 100 miles in breadth from north to south. This work, which was completed in 1874, comprises an area of about 87,000 square miles. It was published on a scale of 4 miles to an inch in approximate contour lines 300 feet apart. The work was controlled by triangulation; heights were measured by barometer and by vertical angles, and sketching was done in note books, the sketches being adjusted to the locations in the office.

Survey west of the 100th Meridian.—This was the most extensive of the surveys within the Cordilleran region. It was commenced in 1862, and for several years was carried on by traverse methods similar to those followed by the other explorations under the War department, and the maps produced were published on a scale of 8 miles to an inch, the relief being expressed by hachures. In 1872-3-4-5 the methods of this survey were radically improved. A system of control by triangulation was adopted, the scale of publication was increased from 8 to 4 miles to an inch, and areas, instead of lines of travel, were mapped. This survey was discontinued in 1879. The entire area surveyed is said to have been 361,000 square miles, of which 103,000 square miles was on a scale of 4 miles to an inch, the balance being on that of 8 miles to an inch.

The Hayden Survey.—This organization, which was initially a geologic exploration, was instituted in 1867. No topographic work was done by it until 1871, when certain route surveys were made in Montana, Idaho and Yellowstone park. In 1872 similar surveys were carried on in the same region. Between 1873 and 1876, inclusive, the work of this organization was confined to Colorado and adjacent strips of Arizona, New Mexico and Utah, while in 1877 and 1878 work was done in Wyoming, Idaho, Utah and Yellowstone park. During 1874 and following years the methods of survey were greatly improved. The work was controlled by triangulation originating in measured bases, within which was a secondary triangulation, by means of which nearly all control points were located; traverse being used to locate only minor details of roads, streams, etc. Sketching was done in note books, and the sketching was adjusted to the control in the office. The maps were published on a scale of 4 miles to an inch, in approximate contour lines 200 feet apart. Altogether an area of about 100,000 square miles was surveyed by this organization, which was discontinued in 1879.

Powell Survey.—This survey originated in an exploration of the Colorado river, commenced in 1867. After the completion of this exploration, systematic work was undertaken in the territory of Utah, and up to the time of the discontinuance of the survey in 1879 about 67,000 square miles had been surveyed, comprised in Utah and the northern part of Arizona. The methods of work were quite similar to those of the Hayden survey, but with this notable exception, that the minor control and the sketching were done upon planetables, the sketching being adjusted to the control in the field upon the stations. The maps were published by the present Geological survey on a scale of 1:250,000, the relief being expressed by contours 250 feet apart.

Boundary Surveys.—The boundary lines of many of the western states and territories have been run at the expense of the general government, and in connection with these boundary surveys narrow strips of topography have been mapped.

In 1875, when public attention had become drawn to the gold deposits of the Black hills, an exploration of this region was undertaken by the Indian bureau under the authority of the general government. This exploration included both the preparation of a topographic map and a geologic examination. The

map was produced on a scale of 4 miles to an inch in approximate contour lines.

Public Land Surveys.—In the latter part of the last century a system was devised for the subdivision of the public lands held by the United States, for the purpose of cutting them up into convenient parcels for sale or other mode of disposal. The system then devised has been extended with little modification over all the states, with the exception of the thirteen original colonies, together with Maine, Vermont, Kentucky, Tennessee and Texas. Many of the states have been surveyed entirely under this system, while the others have been in greater part surveyed.

The method of subdivision is a very simple one, and is learned by every western child in connection with the alphabet. An initial point is selected from which a base line is run east and west and a principal meridian is run north. At intervals upon this base line, ranging from twenty-four miles upward, other lines are run north, known as guide meridians, and at similar intervals on the principal meridian secondary east-and-west lines are run, known as correction lines. The blocks of country thus laid out into approximately rectangular shape are subdivided into approximate squares by running lines northward, eastward, and westward at intervals of six miles, forming what are known as townships. Each township is then subdivided by means of lines run at every mile in both directions, forming sections, each section being approximately a mile square. The north lines are theoretically run on true meridians and therefore converge, the convergence increasing from the base line northward until a correction line is reached. Upon the correction line a new start is made, the townships and sections resuming their former bases of six miles and one mile respectively.

The principal and guide meridians, the base lines and correction lines, as well as all other township lines in this work, are run by solar compass, and distances are measured by chain with considerable care. The subdivision of townships into sections is generally done with a compass, and the chaining is executed with less care. The accumulated errors in the survey of a township are thrown into the northern and western tiers of sections, culminating in the northwestern corner.

In the prosecution of these surveys no attention has been paid to geographic positions. The initial points have been selected arbitrarily, and it is only by connecting these surveys with posi-

tions determined independently that they have been located. Such determinations have been made in abundance by one means or another, and they are well distributed; so that for maps on small scales there is no difficulty in locating these surveys.

As these surveys have been made merely for the purpose of subdividing the land, little attention has been directed toward making them available for the production of maps. The instructions under which they have been made, however, require that the points of crossing of all streams by the lines of survey be noted, together with the directions of the streams; that all streams above a certain breadth, as well as the borders of all lakes and ponds, be traversed; and that the limits of all swamps and marshes and timbered lands be noted. Had these instructions been everywhere carried out a large amount of geographic information would have been gathered; but unfortunately they have not been fully carried out, and hence the township plats differ greatly in the amount of information which they present. These plats are made on a scale of 2 inches to a mile, a scale many times greater than the degree of detail upon them requires. From these plats, with the addition of information from other sources, the General Land office prepares and publishes a series of very useful state and territorial maps on scales ranging from ten to eighteen miles to an inch, and a map of the United States upon a scale of about 40 miles to an inch.

There is another group of maps published by the general government, the material of which is in the main, compiled, but which contains certain elements of originality. These are the postal-route maps which are prepared by the Post-office department for illustrating the location of post-offices and the lines of transportation of mails. The natural features of these maps are of course compiled. The boundary lines of counties, on the contrary, are in the main laid down directly in accordance with statute. The location of railroads is effected mainly by means of plats furnished directly from the railroad surveys, and the location of post-offices is in a corresponding measure derived from similar sources.

With the exception of a few minor matters, the above list covers the survey works and the sources of geographic information furnished by the general government. We turn next to the work done by the various state governments.

NEW YORK

New Hampshire.—This State has reported recently a good map survey, which has retaken the preparation of a topographic map, a new edition was effected, mainly, however, by connecting the original work being done. A number of positions in the State were obtained from the United States Coast and Geodetic Survey and to these were added traverses or runs which had previously been obtained by private enterprise. Upon this skeleton a so-called preliminary contour map was produced by using the heights for profiles of the railroads of the State, supplemented by numerous aneroid measurements made by the geologic survey. This map was printed on a scale of 24 miles to an inch with a contour interval of 100 feet. It was issued in 1888.

New York.—From 1857 to 1884 the State of New York obtained a survey under Mr J. T. Gardner. By this survey much triangulation of a high degree of accuracy was carried on, but the topographic work was executed. The State has for a number of many years an organization known as the Adirondack survey, which was organized for the purpose of mapping the Adirondack region. No results, however, have been published beyond the positions of a few geodetic points and a large number of measurements of altitudes.

Pennsylvania.—In Pennsylvania a considerable money has been expended in topographic surveys for special purposes and there have been on so large a scale and are so different in character that, already, they are of great importance. Most of them are on the scale of 1 inch to a mile, which contains 14 or 20 feet to an inch.

Tennessee.—In Tennessee a fine work was done in the southwestern part of the State by the State geologic survey. This work was based on the triangulation of the United States Coast and Geodetic Survey. The Land Office plans were utilized and the relief was expressed by 50-foot contours.

Minnesota.—Most of the area of Minnesota has been mapped by the State geologic survey on a scale of 4 miles to an inch, or 1 inch to 20 miles. The horizontal element of this map was furnished by the surveys of the General Land Office, the vertical element being supplied from the profiles of railroads supplemented by aneroid measurements.

Kentucky.—Large maps of many of the counties of Kent-

They have been prepared from traverses of the lands. These maps, which make scale 1:100,000 by the relief, are published at a scale of 1:250,000 to 1:500,000.

California.—In 1849 and 1850 the state of California, then a new possession, was by her one of the best regulated geographic surveys found at present. It devoted half of its annual budget to topographic maps. In this organization a large part of contracted labor was supplied, the greater part being on a scale of 10 miles to an inch, with a small area about the bay of San Francisco, was on a scale of 2 miles to an inch. The relief is both across of maps being expressed by hachures.

New Jersey.—The only state which has for the period of forty years operated a reasonable and continuous plan for mapping its area is New Jersey. In 1837 the state commenced surveys for mapping a connection with its general survey upon a plan, and by methods very similar to those subsequently adopted in the geologic survey of the United States. This work was continued by triangulation, in the main executed by the United States Coast and Geodetic Survey and supported by the state. The general control was maintained by means of traverse lines. The traverses were measured by a level and vertical angles. The resulting maps were published on a scale of 10 miles to an inch, in some cases of 10 and 20 feet. When the state was a small survey of the United States through a survey in connection and carried the work through to completion upon the same plan and by the same methods which the state had originated.

PRIVATE SURVEYS

In the period of the report of the government and the other of mapping this country, a wide field had been left open for private enterprise, and this field has been worked actively, but with various results. Maps have been produced by private persons or partnerships, some of them in the southern states, and a few in the countries of the northern states. The material for these maps has been obtained by traverse surveys and other means. These maps are generally of a nature and can be characterized in a very few words. They are essentially a synthesis of sound. The houses and the towns are generally represented together with the names of the owners, as this is said that this is not the scale of the maps. Streams are best today represented in relief as only a few.

The standard material which is adapted for smaller scales has been considerably revised so that the map may reflect the by and by nature. Except for certain important vegetation areas, relief is not indicated at all. Still the fact should not be overlooked that by the large proportion of contours of 1,000 feet above sea level the larger scales. In the remaining places the relief element is not of so great a value.

Of the area of 3,100,000 square miles 1,400,000 square miles are added to the areas above mentioned and be mapped. Of this area 1,200,000 square miles are furnished by the maps of the United States and 100,000 square miles by country maps of the New England states, both of which classes of maps show no relief. 100,000 square miles are included from the 1:62,500 scale of the Wheeler survey, which shows relief by hachures. The portion of country maps from various sources. On this basis, therefore, a map including 1,400,000 square miles or nearly five sixths of the country, can be prepared showing topography and elevation.

A reduction of the scale to 1:15 inches to one inch, or about 1:1,000,000, represents but little the area possible to map. It includes only such parts of the southeastern states as are not already shown on a portion of Texas, and some trifling areas in the borderland region. The southeastern states have no representation on this scale by the aid of compilations of railroad maps, war maps, etc. notably the compilation made by the United States Coast and Geodetic Survey during the civil war the compilation of North Carolina made by Frederick W. L. Kerr and others.

A compilation from railroad surveys has been made of Texas which, excepting for the western part of the state will answer for this scale. In the borderland region some state surveys not included in later maps have been run over on a large scale by army

and navy engineers and are available for use.

Legends

All together, an area of about 2,000,000 square miles can be mapped on this scale. Land area besides Alaska, about 225,000 square miles which is a little less than to be represented on a scale of 1 inch to 100 miles.

Much of our material is necessarily obsolete in its character because the surveys were executed many years ago and in the interval which has elapsed this character has changed greatly. This is particularly the case in the west, where

III. *How to use the Mammal Index for Ecological Studies*

most of the present material on mammal distribution has been published since the work of A. S. Hayter. We are, therefore, not lower than we are.

For the purpose of the study of the distribution of the mammals of the United States, the index is a valuable tool. It is a good index of the mammals of the United States of great value. It is a good index of the mammals of the United States of great value. It is a good index of the mammals of the United States of great value.

SUMMARY

A mammal index of the mammals of the United States

which has been compiled by the U. S. Fish and Wildlife Service and the U. S. Department of the Interior. It is a good index of the mammals of the United States of great value. It is a good index of the mammals of the United States of great value. It is a good index of the mammals of the United States of great value.

The index is presented in the form of a table of the mammals of the United States of great value. It is a good index of the mammals of the United States of great value. It is a good index of the mammals of the United States of great value.

The scale of 1:1000,000 is a good scale for the mammals of the United States of great value. It is a good index of the mammals of the United States of great value. It is a good index of the mammals of the United States of great value.

Northern Mexico

Northern California of New York

South Carolina

Western California of Montana

The Canadian and United States of Oregon and Washington

Western North Dakota and South Dakota

Western Texas and Eastern New Mexico

Areas represented on the various Mother Maps of the United States and available for compilation on certain selected States.

Scale (million to one inch)	Surveyed by—	Area in square miles.	Total area in scale.	Total available for scale.	Remarks.
1.	Count and Geodetic survey. Geographical survey.	51,000 60,000	100,000	100,000	All in contours.
2.	Geological survey.	200,000	300,000	400,000	All in contours.
4.	Geological survey. Powell survey. Hayden survey. Northern Transcontinental sur- vey. King survey. Wheeler survey.	120,000 67,000 80,000 40,000 97,000 60,000	464,000	464,000	All but 60,000 in contours.
8.	Wheeler survey. Land Office surveys. Private surveys. Miscellaneous surveys.	100,000 2,250,000 200,000 50,000	2,500,000	2,450,000	50,000 in contours; 100,000 in high- ways; remainder above in relief.
16.	Miscellaneous surveys.	350,000	350,000	350,000	Same as above.

The territory of Alaska is still in the exploration stage. Its condition, as regards our geographic knowledge of its area, is quite similar to that of the Cordilleran region half a century ago. The shore line has been explored and laid down upon charts in its approximate position, and a part of the intricate shore line of southeastern Alaska has been mapped with some accuracy. The interior of the territory has been traversed by a number of expeditions, and thus a few routes have been surveyed; but far the greater part of the interior is still utterly unknown.

